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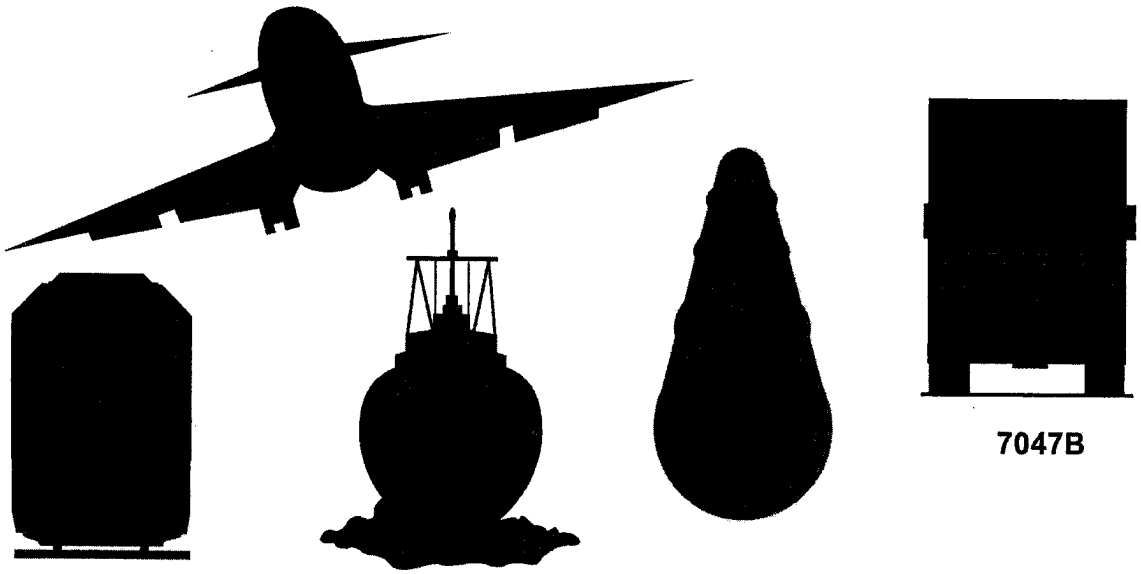
NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

CRASH DURING LANDING
FEDERAL EXPRESS, INC.
MCDONNELL DOUGLAS MD-11, N611FE
NEWARK INTERNATIONAL AIRPORT
NEWARK, NEW JERSERY
JULY 31, 1997



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National Transportation Safety Board
490 L'Enfant Plaza, S.W.
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National Transportation Safety Board. 2000. *Crash During Landing Federal Express, Inc. McDonnell Douglas MD-11, N611FE, Newark International Airport, Newark, New Jersey, July 31, 1997.* **Aircraft Accident Report NTSB/AAR-00/02. Washington, DC.**

Abstract: This report explains the accident involving Federal Express flight 14, an MD-11, which crashed while landing on runway 22R at Newark International Airport, Newark, New Jersey, on July 31, 1997. Safety issues discussed in this report focus on landing techniques, bounced landing recovery, and training tools and policies that promote proactive decision-making to go around if an approach is unstabilized. Safety issues also include the use of on board computers to determine the required runway length for landing, MD-11 handling characteristics and structural integrity requirements, hard landing inspection requirements, and tracking hazardous materials.

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1. Factual Information

1.1 History of Flight

On July 31, 1997, about 0132 eastern daylight time,[1] a McDonnell Douglas MD-11,[2] N611FE, operated by Federal Express, Inc., (FedEx) as flight 14, crashed while landing on runway 22R at Newark International Airport (EWR), Newark, New Jersey. The regularly scheduled cargo flight originated in Singapore on July 30 with intermediate stops in Penang, Malaysia; Taipei, Taiwan; and Anchorage, Alaska. The flight from Anchorage International Airport (ANC), Anchorage, Alaska, to EWR was conducted on an instrument flight rules flight plan and operated under provisions of 14 Code of Federal Regulations (CFR) Part 121. On board were the captain and first officer, who had taken over the flight in Anchorage for the final leg to EWR, one jumpseat passenger, and two cabin passengers.[3] All five occupants received minor injuries in the crash and during subsequent egress through a cockpit window. The airplane was destroyed by impact and a postcrash fire (see figures 1 through 4).

According to flight plan and release documents, the airplane was dispatched to ANC with the No. 1 (left engine) thrust reverser inoperative.[4] The flight plan time from ANC to EWR was 5 hours and 51 minutes—47 minutes shorter than the scheduled time of 6 hours and 38 minutes because of 45-knot tail winds en route. The flight crew stated that at flight level (FL) 330 (about 33,000 feet mean sea level [msl]), the flight from ANC to EWR was routine and uneventful.

At 0102:11, a Federal Aviation Administration (FAA) Boston Air Route Traffic Control Center air traffic controller instructed flight 14 to descend and maintain FL 180, according to the airplane's cockpit voice recorder (CVR).[5] About 0103, the captain and first officer discussed the approach and landing to runway 22R and the airplane's landing performance.[6] Using the airport performance laptop computer (APLC),[7] the first officer

[1] Unless otherwise indicated, all times are eastern daylight time based on a 24-hour clock.

[2] Boeing Commercial Airplane Group acquired the holdings of Douglas Aircraft Company and McDonnell Douglas in 1997. The MD-11 was developed by McDonnell Douglas as a follow-on to the DC-10, which first flew in 1970. According to *Jane's All the World's Aircraft*, the MD-11, which was granted a type certificate on November 8, 1990, has, among many design changes, a longer fuselage, a redesigned tailplane, winglets above and below the wingtips, and advanced cockpit instrumentation.

[3] The jumpseat passenger was a pilot for another airline, and the two cabin passengers were FedEx employees.

[4] A jet engine thrust reverser deflects airflow in the forward direction to help reduce the airplane's speed after touchdown. Maintenance personnel at ANC deactivated the No. 1 thrust reverser after finding a delaminated door on it. Flight 14's departure with an inoperative thrust reverser was approved under provisions of the airplane's minimum equipment list (MEL). The MEL is developed by each operator of an aircraft and must be equivalent to or more conservative than the master MEL, which is developed by the manufacturer and approved by the FAA.

[5] See appendix B for a transcript of the recording.

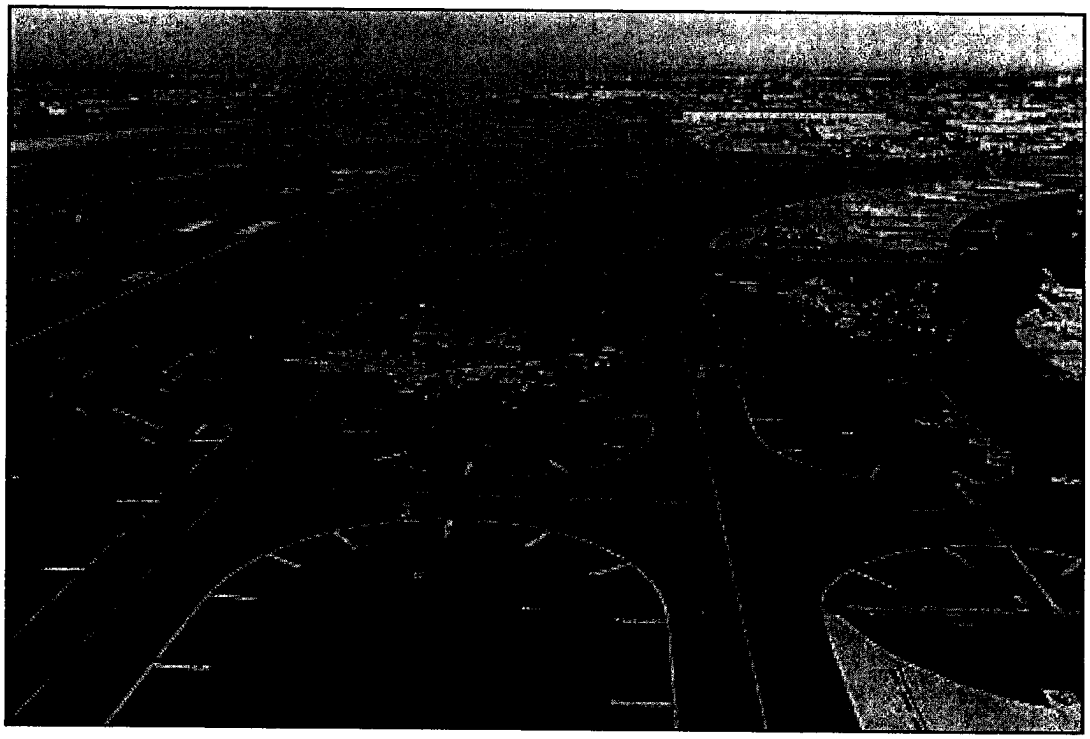

Figure 1. Aerial view of the accident site.

determined that the airplane's runway stopping distance would be approximately 6,080 feet using medium (MED) autobrakes. According to the CVR, at 0103:33, the flight crew then compared the APLC approximate landing distance for MED braking (6,080 feet) to the after-glideslope touchdown distance (6,860 feet) provided on the instrument approach plate.[8] Based on the flight crew's calculation (6,860 – 6,080), MED braking provided a 780-foot margin after stopping.[9] The flight crew then compared the APLC approximate landing distance for maximum (MAX) braking (5,030 feet) to the same 6,860-foot after-glideslope touchdown distance provided on the instrument approach plate. Based on the flight crew's calculation (6,860 – 5,030), MAX braking provided a 1,830-foot margin after stopping.[10] On the basis of these calculations, the first officer suggested using MAX autobrakes. The captain agreed, stating "we got a lot of stuff going

[6] Runway 22R is 1,100 feet shorter than runway 22L, which was closed (see section 1.10 for a discussion of airport information).

[7] As an airplane approaches the landing airport, pilots enter several parameters (for example, weather information and airplane weight) into the APLC, which generates landing data, including the approximate landing distances for usable runways at a selected airport.

[8] The APLC approximate landing distance is intended to be compared with the APLC runway distance, which, in this case, is 7,760 feet.

[9] Based on APLC data (7,760 – 6,080), MED braking would have provided a 1,680-foot margin after stopping.

[10] Based on APLC data (7,760 – 5,030), MAX braking would have provided a 2,730-foot margin after stopping. Following the accident, FedEx expanded the APLC training presentation that was originally included in initial and upgrade training. This expanded presentation has also been added to recurrent training programs.

Figure 2. N611FE at the height of the firefighting effort.

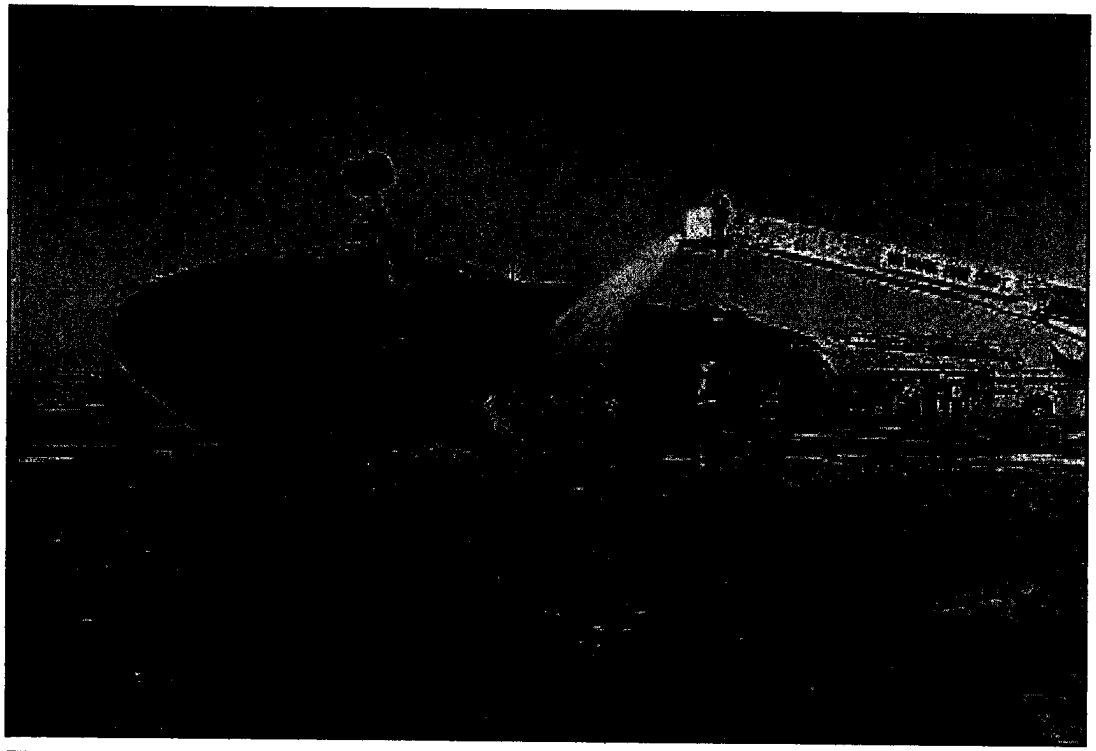

Figure 3. N611FE during the final portion of the firefighting effort.

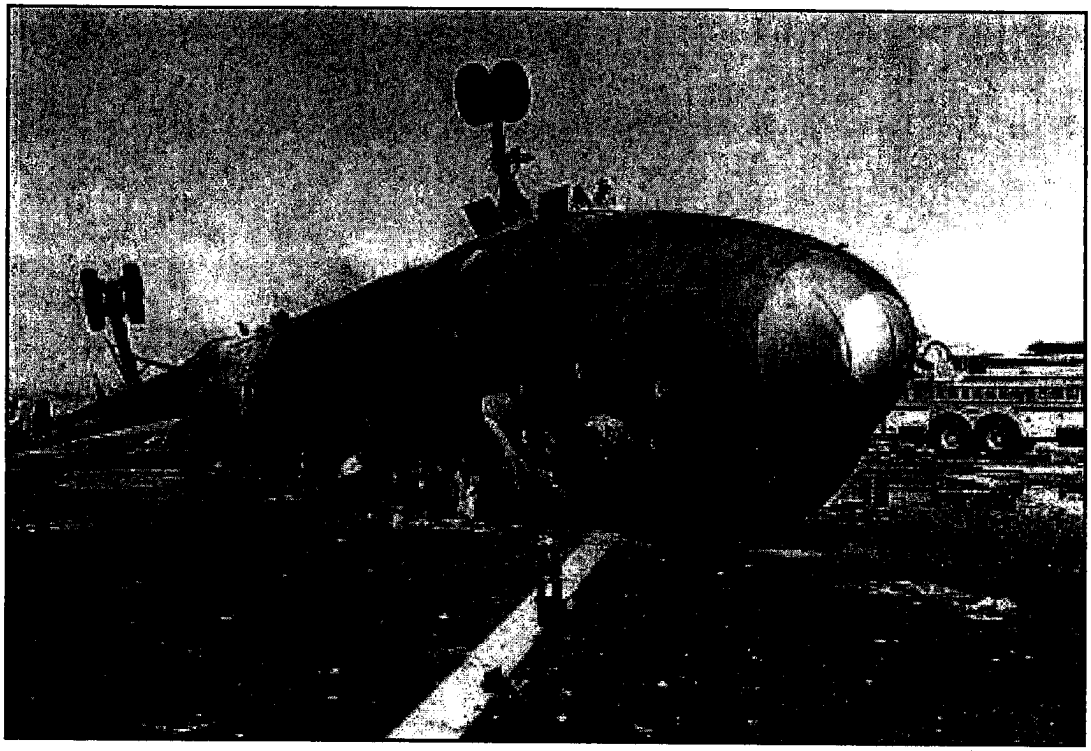

Figure 4. N611FE after the fire was extinguished.

against us here so we'll...start with max." The first officer added, "I mean...I mean if we don't have the reverser."

At 0114:22, the captain asked the first officer to advise the passengers that "we're gonna have a pretty abrupt stop because of those brakes and the thrust reversers and all that stuff." Twice during the approach, the captain asked the first officer to remind him to only use the No. 2 and No. 3 thrust reversers.[11] At 0116:16, the captain noted that the left landing light was inoperative, adding "... just the right's working."[12]

The EWR tower controller cleared flight 14 to land at 0129:45 and advised the flight crew "winds two five zero at five." At 0130:02, the first officer stated "max brakes" during the before-landing checklist. The captain replied "max brakes will be fine," and the first officer responded "if they work."[13] At 0130:34, the captain stated "[landing gear] down in four green" and called for "flaps fifty."

[11] At 0102:22, during the approach briefing, the captain stated "ah...remind me to, we just want two and three for reverse." At 0130:59, the captain stated "two and three on reverse...just in case I forget." The No. 3 thrust reverser can be deployed on main gear spinup. The No. 2 thrust reverser cannot be deployed until after nose gear touchdown.

[12] Landing lights are located on the fuselage aft of the L1 and R1 cabin doors. According to the MEL, flights can be conducted at night with inoperative landing lights if the nose gear lights are functioning. The captain told National Transportation Safety Board investigators that the inoperative left landing light did not affect his ability to judge sink rate and land the airplane.

At 0130:45, the captain disengaged the autopilot at an altitude of 1,200 feet during the approach and "hand flew" the airplane to touchdown. The autothrottles were engaged, as recommended by McDonnell Douglas and FedEx procedures.[14] According to information from the airplane's flight data recorder (FDR), the approach was flown on the glideslope and localizer until touchdown,[15] and the airplane's approach airspeed was about 158 knots until the flare. According to the CVR, the pilots had selected an approach reference speed of 157 knots, or V_{ref} plus 5 knots.[16] Altitude callouts were made by the on board central aural warning system (CAWS) at 1,000 feet and 500 feet, and the first officer called out minimums (211 feet) at 0132:03. At 0132:09, the first officer stated "brakes on max," and CAWS callouts followed for 100, 50, 40, 30, 20, and 10 feet until the sound of initial touchdown at 0132:18.75. One-half second later, the CVR recorded an expletive by the captain. At 0132:20.26, the CVR recorded increasing high-frequency tones consistent with engine spool-up (accelerating engine rpms), and at 0132:21.06, the CVR recorded a decrease in high-frequency tones consistent with engine spool-down. The sound of a "loud thump" consistent with another touchdown was recorded at 0132:21.62. A series of expletives by the captain and first officer followed until sounds of "metallic breakup" were recorded at 0132:27.

FDR data indicated that after the airplane's initial touchdown, it became airborne and rolled to the right as it touched down again (see section 1.1.1 for a detailed description of the airplane's performance during the landing sequence). The airplane continued to roll as it slid down the runway, coming to rest inverted about 5,126 feet beyond the runway threshold and about 580 feet to the right of the runway centerline. The accident occurred during the hours of darkness. Visual meteorological conditions prevailed at the time of the accident.

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[13] The MD-11's autobrakes, or automatic brake system (ABS), automatically apply brakes during landing and rejected takeoff. The takeoff mode is armed by selecting "T.O. [takeoff] with the AUTO BRAKE selector," according to the MD-11 flight crew operating manual (FCOM). The ABS landing mode is armed after the gear is down. The accident airplane's maintenance logs contained three write-ups about instances in which the autobrakes failed to arm at takeoff or failed to function properly on landing. Maintenance personnel checked the system after each reported failure but found no anomalies. The captain told Safety Board investigators that he discussed the reliability of the autobrakes with the first officer in ANC and elected to execute a MAX power takeoff because of the possibility of autobrake failure in the takeoff mode. However, he added that the autobrakes performed normally on takeoff in ANC. He stated that he kept the possibility of autobrake failure in mind when planning for landing at EWR.

[14] During the approach, the captain selected APPROACH LAND and FMS SPEED rather than selecting SPEED SELECT on the flight control panel (FCP) of the flight management system (FMS). In the FMS SPEED mode, the flight management computer (FMC) adjusts the airplane's speed in relation to configuration changes (for example, leading edge slat, flap, and landing gear extension). In the SPEED SELECT mode, the captain would have had to adjust the airplane's speed after each configuration by changing the speed on the FCP.

[15] The first officer told Safety Board investigators that runway 22R's three-bar visual approach slope indicator (VASI) was in operation and visible from the cockpit. He stated that during the approach, the airplane was on the lower path of the VASI system, or red-red-white. Three-bar VASI installations provide two visual glidepaths. The lower glidepath, provided by the near and middle bars, is normally set at 3°. The upper glidepath, provided by the middle and far bars, is normally set 1/4 degree higher.

[16] V_{ref}, in this case, was a target or reference approach speed. Reference approach speeds are typically about 1.35 V_{so} (stalling speed with flaps in the landing configuration).

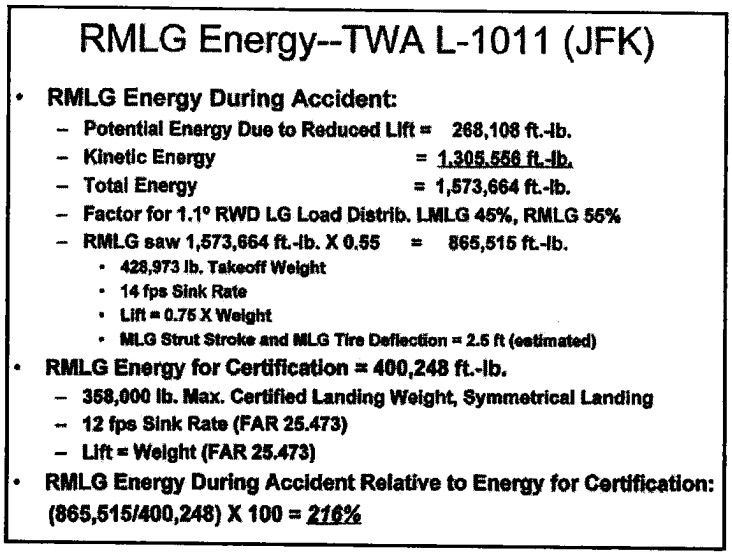

Figure 11. Boeing calculations of right MLG energy in the TWA L-1011 accident.

1.18.7 Other Landing Accidents

The Safety Board has investigated or participated in the investigation of several accidents in which pilots mishandled the airplanes during the landing phase. For example, in 1993, an American Airlines McDonnell Douglas DC-10 was destroyed during landing at Dallas-Fort Worth International Airport, Dallas, Texas.[91] The Board's investigation found that although the touchdown was uneventful, the airplane veered off the side of the runway shortly thereafter because the captain held insufficient downward pressure on the control yoke after touchdown and attempted to steer the airplane with the tiller rather than through rudder application.

The Safety Board also assisted with the international investigations of three similar landing accidents involving Boeing 767s: an Asiana Airlines 767-300 in Cheju Island, South Korea, on January 16, 1992; American Airlines flight 957 in São Paulo, Brazil, on October 27, 1992; and LOT flight 002 in Warsaw, Poland, on December 31, 1993. Each accident occurred when the pilots applied large nose-down control column deflections after MLG touchdown, which resulted in large nose-down pitch rates and high vertical velocities at the nose gear. The combination of vertical velocity and pitch rate at nose-gear contact resulted in compression loads that exceeded the design loads of the forward fuselage crown structure.

Although Boeing had published landing techniques[92] in its flight training manual, which were furnished to Boeing 767 operators before these accidents occurred, the

[91] National Transportation Safety Board. 1994. *Runway Departure Following Landing American Airlines Flight 102 McDonnell Douglas DC-10, N139AA Dallas/Fort Worth International Airport, Texas April 14, 1993*. Aircraft Accident Report NTSB/AAR-94-01. Washington, D.C.

techniques had not been implemented consistently or completely by all operators. The Safety Board also learned from discussions with Boeing representatives that the DC-10 and MD-11 had experienced similar instances of damage after being mishandled during the post-touchdown derotation maneuver. Consequently, on June 16, 1994, the Board issued Safety Recommendations A-94-118 and -119. Safety Recommendation A-94-118 asked the FAA to:

> Require that all FAA-approved Boeing 757/767 Operating Manuals, and other airplane model Operating Manuals as deemed appropriate, clearly communicate derotation techniques and the potential for excessive pitch rates after touchdown if pilots use large nose-down control column deflections. Such information should be inserted in the sections of the manual that refer to normal and crosswind approach and landing, as a cautionary note. Instructions calling for positive forward control pressure after nose wheel touchdown should be replaced with a warning to smoothly fly the nose wheel to the runway by relaxing aft control column pressure and not to use full down elevator.

In an August 29, 1994, letter, the FAA stated that it had reviewed the FAA-approved Boeing 757/767 Airplane Flight Crew Training Manual and Boeing's "guidance concerning the potential for excessive pitch rates after touchdown if pilots use large nose-down control column deflections." The FAA noted that the derotation procedures specified in the Boeing 757/767 Airplane Flight Crew Training Manual were consistent with those outlined in Safety Recommendation A-94-118 and were "similar to the guidance contained in McDonnell Douglas pilot operating manuals." The FAA also stated that it reviewed other actions by Boeing to "inform Boeing 757/767 pilots of proper derotation procedures," which included specification of proper landing techniques in the 767 Flight Crew Training Manual, issuance of a technical bulletin on proper flare and landing techniques, onsite reviews of proper derotation techniques with all Boeing customers, and review of the issues at a 1993 flight operations symposium. The FAA stated that it had determined that these actions were "effective and...[were] more extensive in addressing this issue than a cautionary note in the FAA-approved Boeing 757/767 Airplane Flight Manual." The Safety Board agreed and classified Safety Recommendation A-94-118 "Closed—Acceptable Alternate Action" on August 1, 1995.

Safety Recommendation A-94-119 asked the FAA to:

> Modify initial and recurrent Boeing 757/767 pilot training programs, and other airplane model pilot training programs as deemed appropriate, to include discussion of derotation accidents.

In response to Safety Recommendation A-94-119, the FAA issued Flight Standards Information Bulletin for Air Transport (FSAT) 95-06, "Derotation Accidents During Landings of B-757/767, DC-10, and MD-11 Aircraft," to all FAA Flight Standards personnel. The FSAT, which was effective February 12, 1995, and expired February 29,

[92] Step five in the published Boeing guidance states that after MLG touchdown, speedbrake deployment, and reverse thrust initiation, the pilot should "smoothly fly the nose wheel onto the runway by relaxing aft control column pressure [and should] not use full down elevator."